

EXHIBITS ON DISPLAY

YOU ARE WELCOME TO VIEW

AND CHECK WITH THE METERS

rectangular probe - alpha

pancake probe - alpha, beta, gamma

tubular probe - beta, gamma

RADIATION

WHAT IS IMPORTANT?

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to

The 42nd Annual Conference on Bioassay,
Analytical, and Environmental Radiochemistry

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How many of you have been
near something that is radioactive?

To live in a radiation-free environment....

how many people would like this?

I Want to Provide You With an Intuitive Understanding

- based upon current scientific understanding
- based upon my personal experiences

1995 - 1996

HUNDRED YEAR ANNIVERSARY
THE DISCOVERY OF
RADIATION AND RADIOACTIVITY

PLUTONIUM CRUCIBLE AND POUR PHOTOGRAPH

Topics

Some early history

Brief review of ionizing radiation

Radioactive contamination

Past uses of radiation and radioactive materials

Present uses of radiation and radioactive materials

Radiation levels found in nature

Low-level radiation influence

What is important?

- Health
- Safety
- Environment
- Economics (associated costs)

PERCEPTION

Perception - examples

- Dumping, from the criminal to the absurd
- Exposure, from a crystal vase to an airline flight
- Environmental protection, from St. Peter's Square to the Diablo Canyon nuclear power plant

rem

the amount of energy deposited
in the human body
by ionizing radiation

1 rem = 1 dollar

5 DOLLAR BILL

YEARLY LIMIT

5 rem or 5 dollars

In one year I received

37 cents of radiation

working as a Plutonium Handler

Collection of Antiques From Livermore Area

- Incorporate materials that are naturally radioactive
- Vaseline glass pitcher - made in 1870's
- Uranium oxide and salts used as colorant
- Made approximately 20 years before discovery of radioactivity
- Yellow-colored glass - 79 A.D., near Naples -
> 1% uranium oxide

Uranium

- First recognized as an unknown element in pitchblende
- Klaproth attempted to separate metal in 1789
- Named it after recently discovered planet Uranus
- Metal first isolated in 1841

HAND X-RAY

Discovery of Radioactivity

- Roentgen discovered X-rays - 1895
- Henri Becquerel - 1896 - looking for relationship between luminescence and emission of penetrating radiation
- Chose uranium salts for the test
- Exposure of a wrapped photographic plate

Film Fogged by Radiation

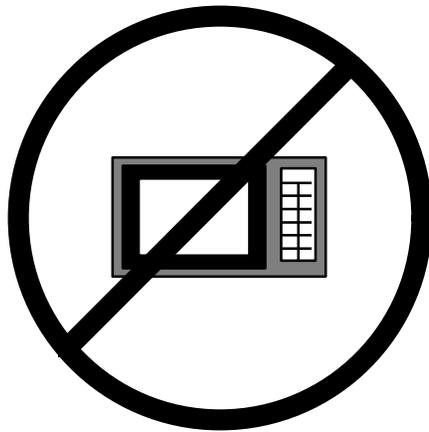
Discovery of Polonium and Radium 1898

- Marie Curie - wanted to identify radioactive materials in pitchblende tailings
- Up to that time, pitchblende mined for uranium's use in glass and glazes
- After discovery, pitchblende mined for radium, uranium considered by-product

WE AREN'T TALKING ABOUT THESE



RADIO



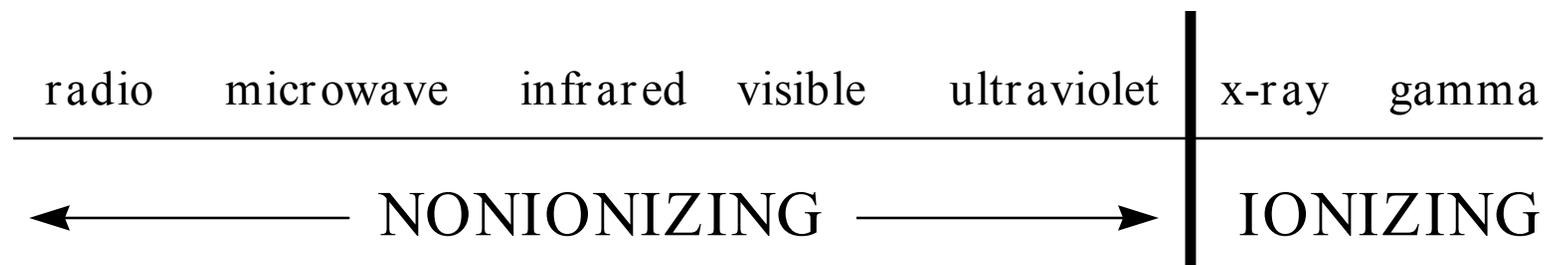
MICROWAVE



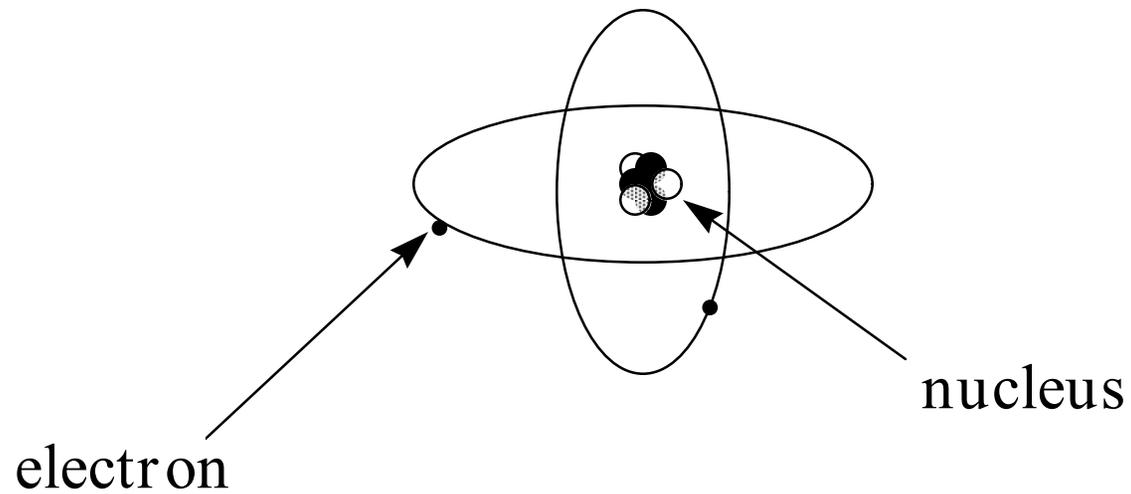
VISIBLE LIGHT

Ionizing Radiation:

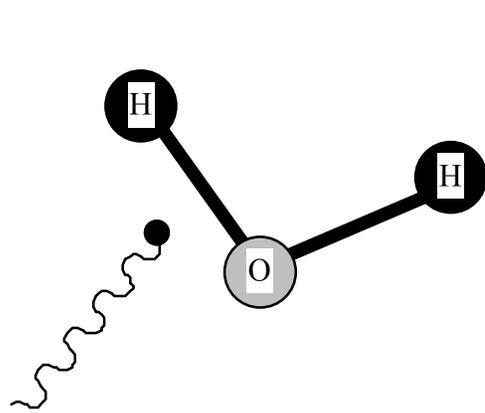
- X-rays
- Gamma Rays
- Atomic Particles



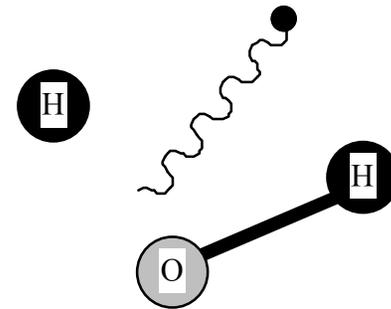
The Atom



RADIATION IONIZATION PROCESS



WATER MOLECULE

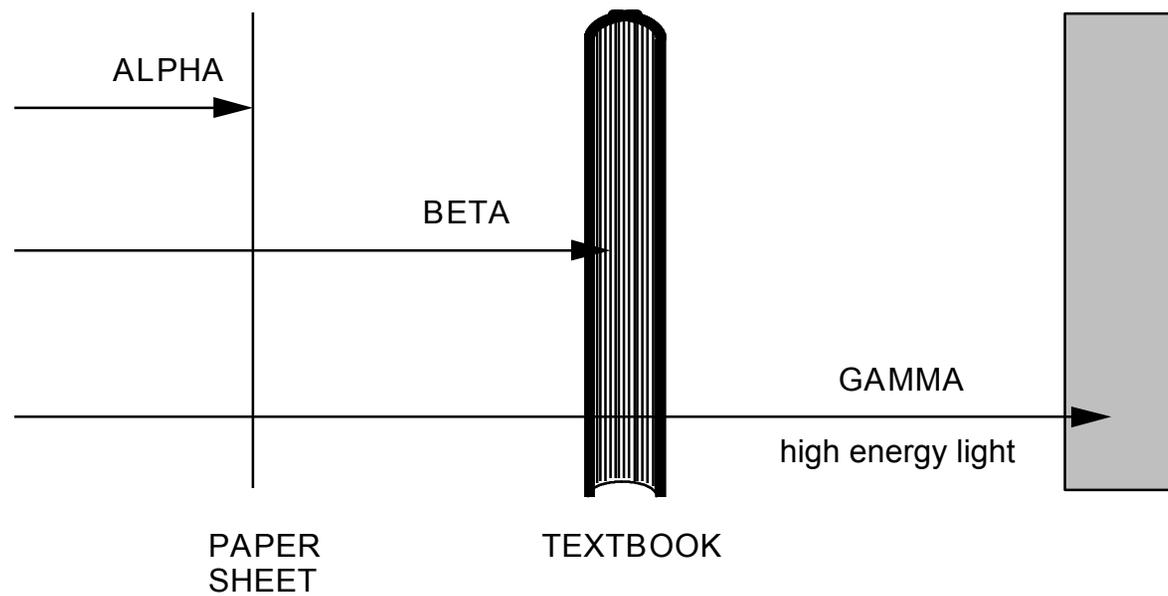


HYDROGEN ION
&
HYDROXYL RADICAL

Shielding - how do you stop them?

- alpha - (helium nucleus) - a sheet of paper
- beta - (electron) - a textbook
- X-ray, gamma - (photon) - lead, concrete, steel
- neutrons - water

WHAT STOPS RADIATION?



Antiques - no detriment to health

- Radioactive material is not in your body
- Mostly beta emission (electrons) - shallow penetration
- Small amount of gamma

<< AND >>

- Just because something is radioactive.....

Radioactive Contamination

- It is not like a spreading contagion (think of a flashlight)
- Can be solid, liquid, or gaseous
- In solid form can be thought of as dust or dirt

Sensitivity of Detectors

- If it's there, we'll find it!
- Just because you detect it, doesn't mean it's harmful

If it's there, we'll find it!

- Body scan and the watermelon
- Body scan and the iodine treatment
- You want to create an environment with no radiation?

Historical and Discontinued

- hair removal - X-ray
- shoe sizing - X-ray
- hair tonic - radium
- tissue cream - radium
- chocolate bars - radium
- toothpaste - thorium, radium

Historical and Discontinued

- dentures - thorium
- paintings (pigment) - uranium
- luminous clock/watch dials - radium
- steel alloying agent - uranium
- radiographic contrast agent - thorium
- photographic toner - uranium

Historical and Discontinued

- cigarette lighter flint - uranium
- high voltage spark gap - radium
- heart pacemaker - plutonium-238
- smoke detectors - radium
- automotive sparkplugs - polonium-210

Half-life

- The amount of time for half of the material to radioactively decay
- Polonium-210 on the spark plug
- Polonium-210 half-life ---- 138 days
- After 138 days, half the original amount is left

My Polonium Tipped Spark Plug

- Made in January 1953
- Mid-May 1953 one-half remains
- November 1953 one quarter remains
- 1960 - less than one millionth remains
- 1980 - less than one billionth billionth remains
- 1994 - less than one billionth billionth billionth remains

? WHAT DOES THIS MEAN ?

Historical and Discontinued

- Radithor medicine - radium & thorium
- Lone Ranger Atomic Bomb Ring - radium
- Adhesive tape dispenser - uranium
- drinking water treatment - radium ore (pitchblende)

Currently Used (natural & man-made)

- reactor fuel - uranium, plutonium
- gas lantern mantle - thorium
- transition glass - uranium
- alpha-voltaic battery - americium
- instrumentation/timepiece lighting - tritium, strontium, promethium, praseodymium

Currently Used (natural & man-made)

- gyro compasses - uranium
- inertia guidance devices - uranium
- sailboat ballast - uranium
- missile reentry vehicle ballast - uranium
- armor protection - uranium
- aircraft control surface counterweight - uranium

Currently Used (natural & man-made)

- radiation treatment - cobalt, cesium, iodine, etc.
- smoke detectors - americium-241
- antistatic devices - polonium-210
- optical lenses - thorium
- weapon detection - x-rays
- food sterilization - cobalt-60

Currently Used (natural & man-made)

- electronic tubes & sparkgaps - thorium, cesium-137
- welding tip for TIG process - thorium
- eye and skin care products - X-rays & gamma rays
- thermoelectric generator - plutonium, strontium-90
- emergency exit signs - tritium
- bomb detection - neutron radiation

Currently Used (natural & man-made)

- gemstone coloration - gamma radiation
- ~~• gemstone coloration - neutron radiation~~
- sabot penetrators - uranium
- vulcanization & crosslinking - X-rays
- magnesium creep resistance - thorium
- thickness gauge - cesium-137

Currently Used (natural & man-made)

- medical instrument sterilization - X & gamma rays
- bone fracture diagnostics - technetium-99
- reactor power monitoring - uranium-235
- jet engine blade - thorium
- deep space power - plutonium-238
- radiation shielding - uranium
- angioplasty - beta radiation

Currently Used (natural & man-made)

- infant toiletries - X-rays & gamma rays
- air filtration - americium-241
- heart circulation diagnostics - thallium
- high temperature crucible - thorium
- latex gloves & condoms - X-rays
- lightning rod - polonium-210
- glass & glaze colorant - uranium

Radiation in the Environment

- Natural
- Naturally Concentrated
- Man Made

PERIODIC TABLE OF THE ELEMENTS
SHOWING ELEMENTS WITH
NATURALLY OCCURRING
RADIOACTIVE ISOTOPES

Natural Radiation

- Cosmic
 - photons
 - atomic particles

- Terrestrial
 - photons
 - atomic particles

Cosmic Radiation Exposure

You are shielded by the atmosphere

- At what elevation do you live?
- Denver exposure approximately twice of D.C.
- How often do you fly?

(0.5 mrem/hr at 30,000 ft)

(1 - 2 mrem/hr - supersonic jet -20 km)

(1 - 10 rem/hr - giant solar flare - supersonic jet -20 km)

Terrestrial Radiation Exposure

- Uranium, Thorium & decay daughters in soil
- Radon gas
- Building materials - stone, rock, concrete

How Much?!

Grand Central Station

0.525 rem/year

St. Peter's Square in Rome

0.4 - 0.8 rem/year

Nature's Nuclear Reactor

- 2 billion years old
- Oklo Uranium Mine, Gabon, Africa
- Discovered in 1970's - uranium batches depleted
- Location composed of six separate reactor cores
- Formed by uranium sand settling out in river delta

Nature's Nuclear Reactor

- Concentrations up to 60% uranium
- River water made it go critical
- Individual reactors ran 600,000 to 800,000 years
- Together they ran millions of years
- Concentrations of U-235 up to 4 times that of today
- It is suspected that others existed

How Much?!

Guangdong Province, China	0.330 rem/year
Radon Springs (France)	1.6 rem/year
Monazite Sands (India)	3 rem/year
Morro Do Ferro (Brazil)	7 - 14 rem/year
Guarapari, Brazil	17.5 rem/year
Ramasari, Iran	48 rem/year

Guangdong Leukemia Plot

Morro Do Ferro

Plant Autoradiograph

How is this possible??

- Cell and DNA repair - back to normal operation
- Cell death with sufficient damage - replaced
- Earth was 10 times more radioactive than it is now

Man Made

- Neutron activated - e.g. cobalt-60
- Neutron transmutation - e.g. uranium to plutonium
- Gamma activated
- Fission products - e.g. strontium-90, iodine-131, cesium-137

What is important?

- You don't want "uptake"
- No eating, smoking, or chewing
- Relatively harmless isotopes external to your body can be harmful within your body

What is the risk associated with uptake?

- Case studies
- The human calibration source

The REVIGATOR

- Designed in early 1900's
- Internally lined with pitchblende ore
- Makes drinking water "healthful" by
irradiation
radon gas injection (pitchblende ore decay)
- 0.25 mR/hr gamma

PERCEPTION

- Probe is picking up 40,000 counts/minute in the REVIGATOR
- Within your body - 500,000 disintegrations/minute
- Your body emits 6000 gamma rays/minute (you are irradiating your neighbors)

Where does this radiation come from?

- Nuclear testing?
- Nuclear power plants?
- Nuclear accidents/waste?

NATURE!

Potassium-40

Carbon-14

Thorium-232

Radon-222

Lead-210

Rubidium-87

Polonium-210

Uranium-238

What if your body was not equipped to handle this radiation?

- Cancers
- Mutations

So why is this?

- Cell repair - back to normal operation
- Cell death - it doesn't continue on

Have you ever heard?

Reproducible experiments have shown that

- Mice exposed to low levels of radiation lived longer than mice that weren't
- Fish exposed to low levels of radiation grew faster than fish that weren't
- Low levels of radiation increases fertility, embryo viability, and decreases sterility and mutations

Mice Radiation Exposure Graph

Have you ever heard that...

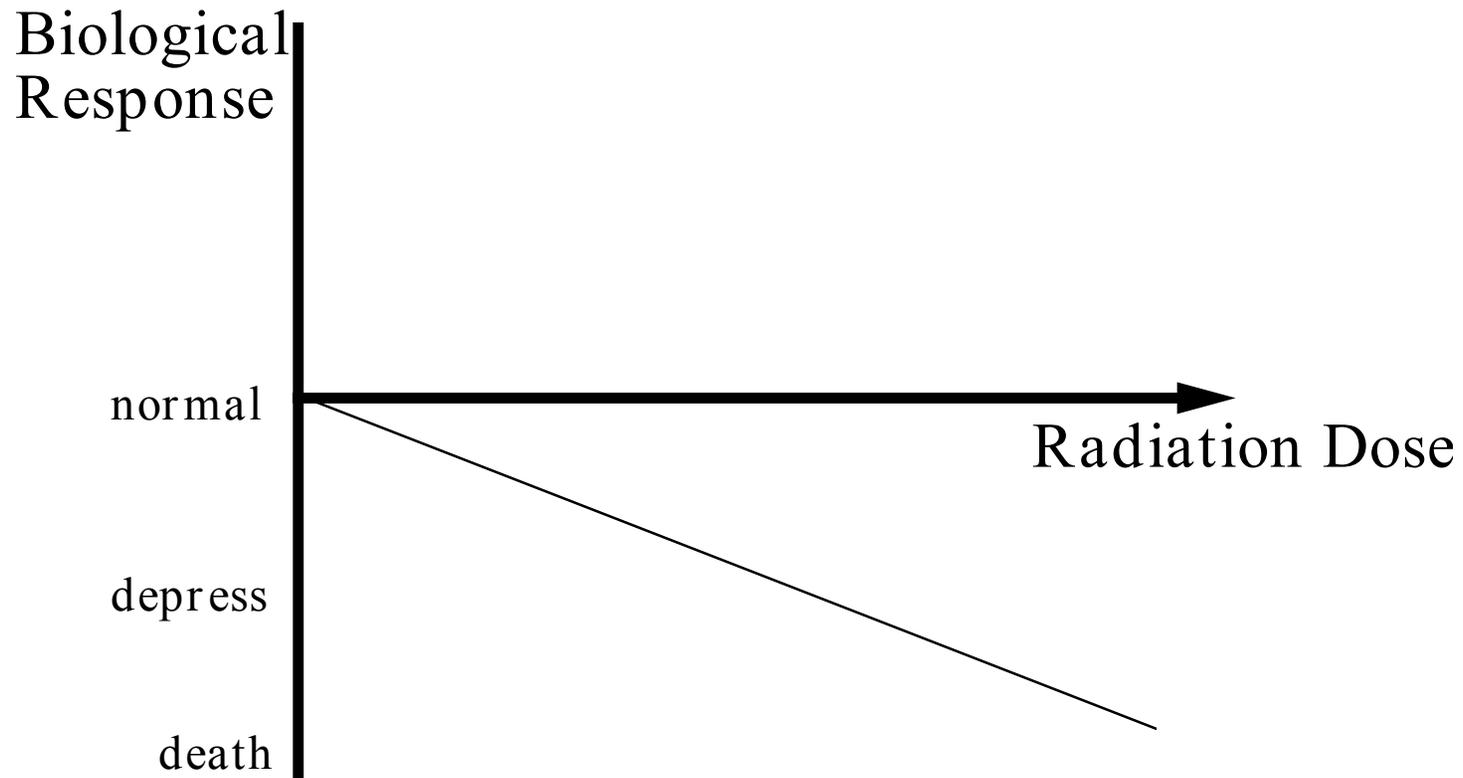
- Low levels of radiation has been shown to improve the immune system response
- Low levels of radiation may be essential to life

But There's More To The Story.....

Three differing concepts regarding radiation's biological effect

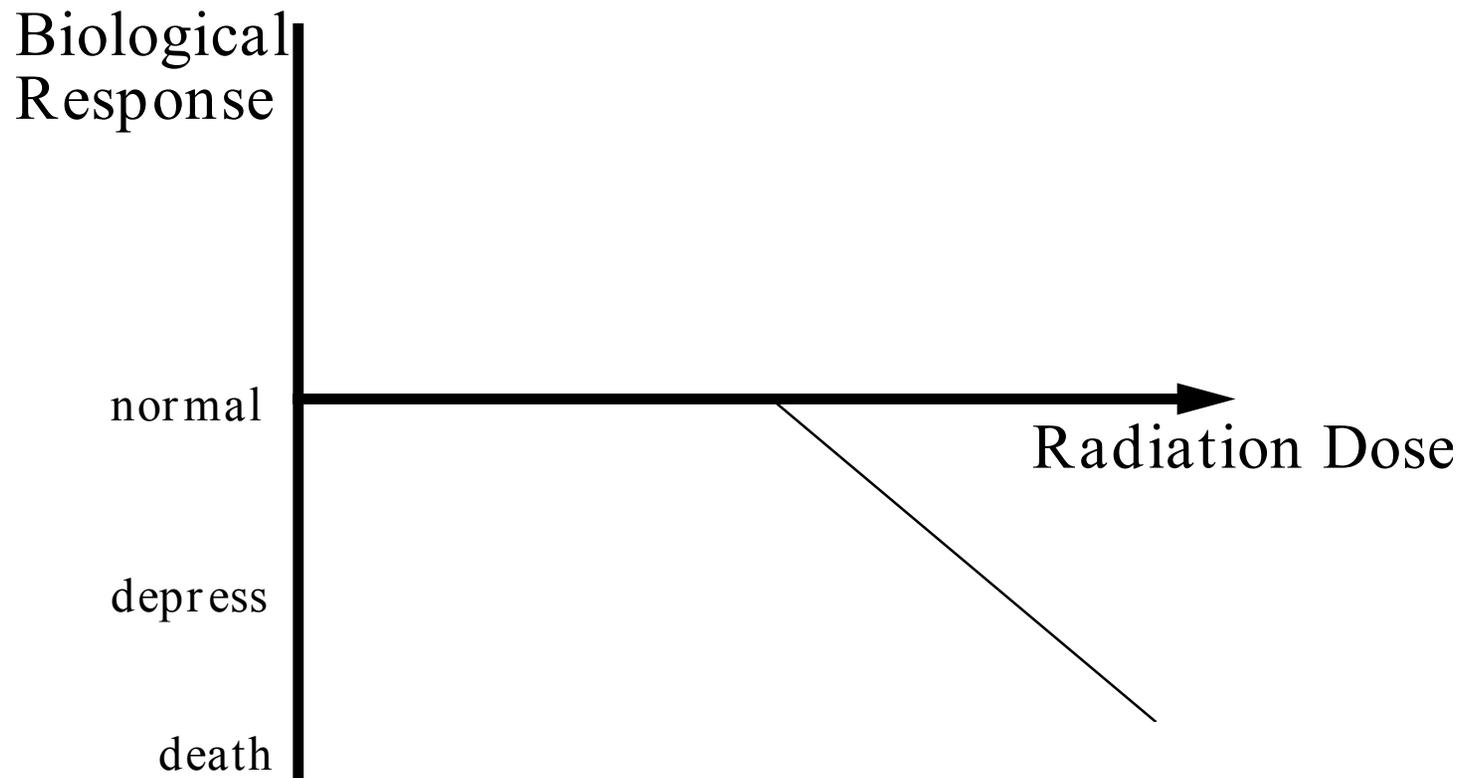
- All radiation is harmful
- There is a threshold dosage level at which radiation becomes harmful
- Low doses of radiation are beneficial while high doses of radiation are harmful

Simplified Linear Model {All Radiation is Harmful}



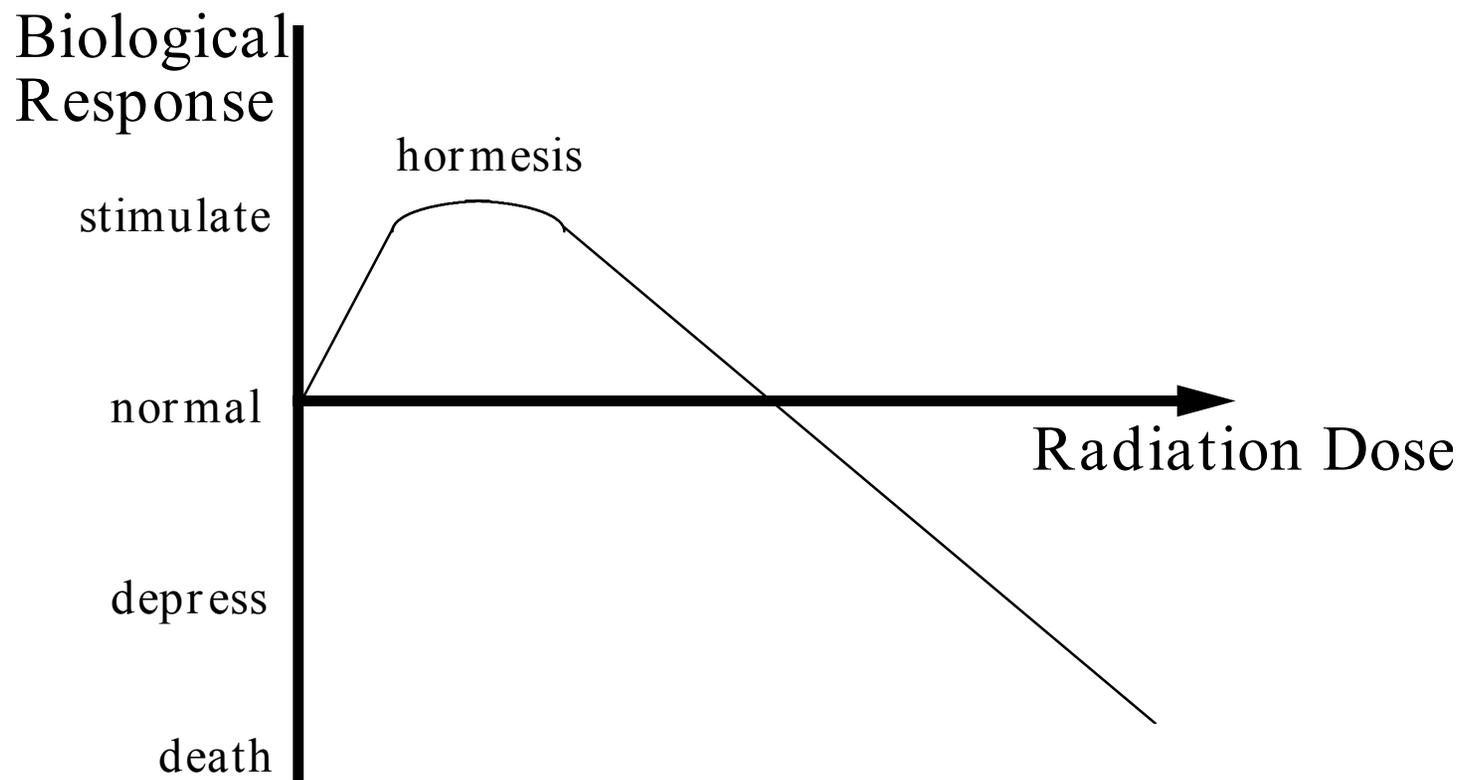
Simplified Threshold Model

{There is a Level Where
Radiation Becomes Harmful}

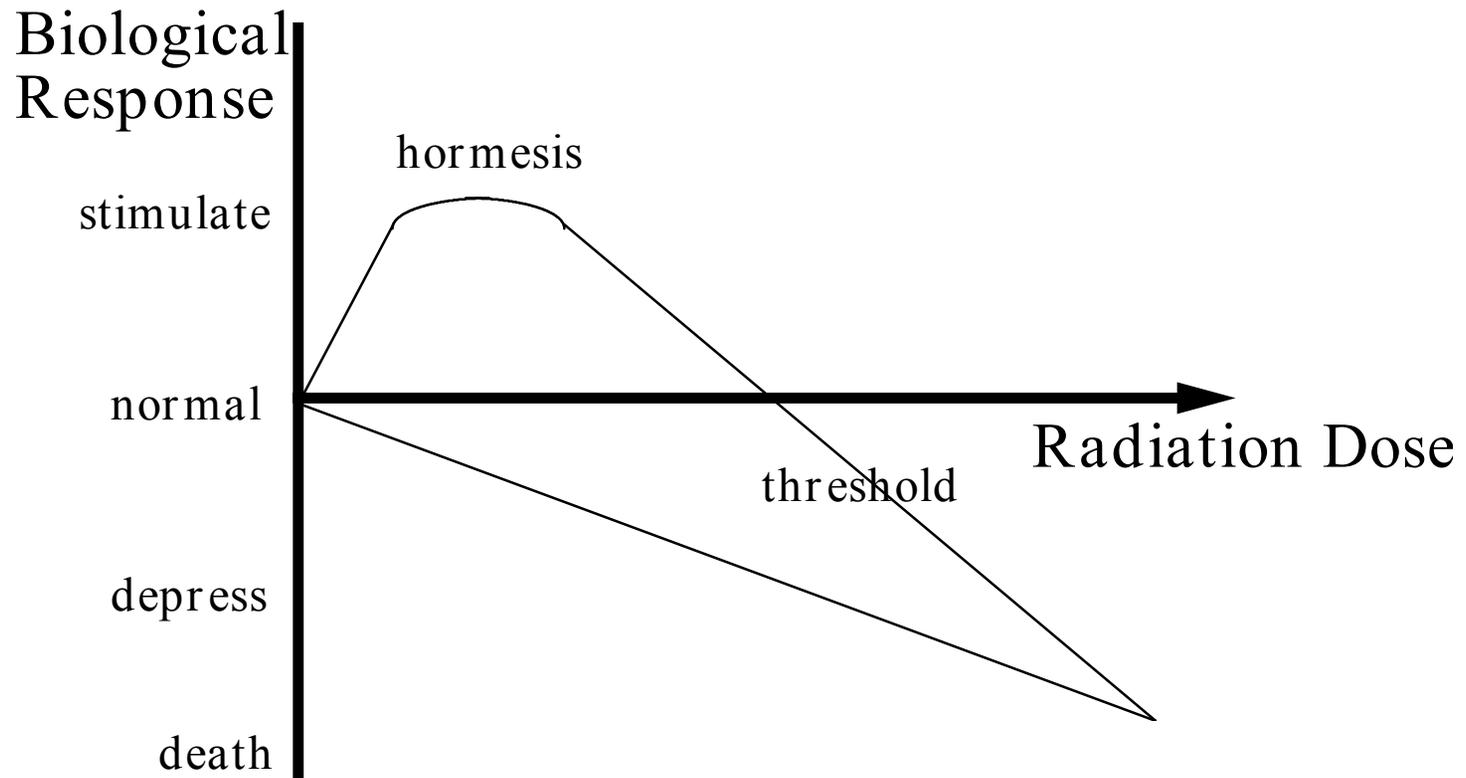


Simplified Hormesis Model

{High and Low Doses
Produce Opposite Effects}



Combined Simplified Models



Recommended Reading

- 1) Environmental Radioactivity from Natural, Industrial, and Military Sources, by Merrill Eisenbud, 3rd edition, Academic Press, ISBN 0-12-235153-3
- 2) Sourcebook On Atomic Energy, by Samuel Glasstone, D. Van Nostrand Company, Inc., 1950
- 3) Medical Effects of Ionizing Radiation, by F. A. Mettler, R. D. Moseley, Grune & Stratton, 1985, ISBN 0-8089-1704-8
- 4) Hormesis With Ionizing Radiation, by T.D. Luckey, CRC Press, 1980, ISBN 0-8493-5841-8
- 5) Radioactivity and Health, Vol. 1 - 3, by J. Newell Stannard, Battelle Memorial Institute, 1988, ISBN 0-87079-590-2
- 6) Radiation Hormesis, by T.D. Luckey, CRC Press, 1991, ISBN 0-8493-6159-1
- 7) Radiation and Radioactivity On Earth and Beyond, by I. Draganic, Z. Draganic, J. Adloff, CRC Press, 1989, ISBN 0-8493-0158-0
- 8) Ionizing Radiation: Protection and Dosimetry, by G. Paic, CRC Press, 1988, ISBN 0-8493-6713-1

Recommended Reading

- 9) DNA Repair, by Errol C. Friedberg, W. H. Freeman and Company, 1985, ISBN 0-7167-1674-7
- 10) Radiation & Human Health, by John W. Gofman, M.D., Phd, Sierra Club Books, 1981, ISBN 0-87156-275-8
- 11) The Dragon's Tail, by Barton C. Hacker, University of California Press, 1987, ISBN 0-520-05852-6
- 12) Nuclear and Radiochemistry, by Gerhart Friedlander, Joseph W. Kennedy, Edward S. Macias, Julian Malcolm Miller, John Wiley & Sons, Inc., 1981, ISBN 0-471-86255-X
- 13) Understanding Radioactive Waste, by Raymond L. Murray, Battelle Press, 1994, ISBN 0-935470-79-4
- 14) The Good News About Radiation, by John Lenihan, Cogito Books, 1993, ISBN 0-944838-34-0
- 15) Trashing The Planet, by Dixy Lee Ray, Harper/Perennial, 1992, ISBN 0-06-097490-7

- Perception -

Natural Occurrence

Do you remember how "hot"
all of my antiques seemed?

- GUMMITE - URANIUM BEARING MINERAL

- Ruggles Mine
- Grafton, New Hampshire
- 6 mrem/hr beta & gamma

THE TEST

<< The Candy Dish >>

Am I safe? ---- Am I not safe?

Why or Why Not?

RADIATION

SOMETHING TO BE
UNDERSTOOD AND RESPECTED,
NOT FEARED

DUMPING INTO AMERICA'S LANDFILLS EVERY YEAR

- Uranium - 23,000 pounds
- Radioactive Thorium - 57,000 pounds

LEACHING OUT INTO OUR NATION'S RIVERS AND UNDERGROUND WATER SUPPLIES

CAT LITTER INDUSTRY

The Common English Garden

- One-tenth acre - first 3 feet of soil
- Uranium - 2 kilograms (4.4 lb)
- Radioactive thorium - 6 kilograms (13.2 lb)

1982 - Radioactive Materials Released Into the Environment of the United States

- 801 tons of uranium
- 1971 tons of radioactive thorium

EPA - 616 million tons of coal burned in 1982

- 1.3 parts per million naturally occurring
- 3.2 parts per million thorium
- 2630 curies of radioactivity released to environment

FEAR?

SO WHAT?

IT NEVER HURT ANYBODY.....

AFTER CHERNOBYL

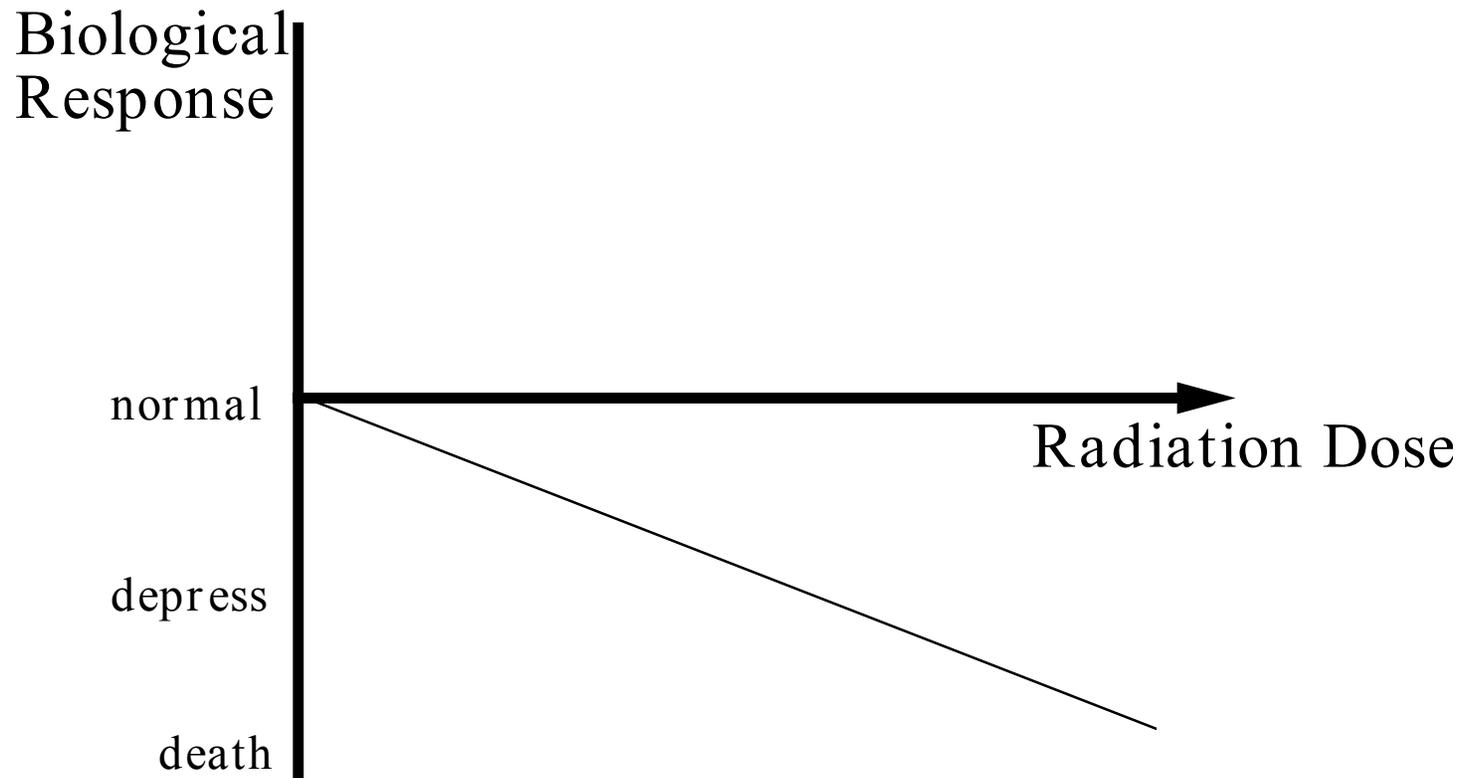
April - September 1986

- Greece - 2000 additional voluntary legal abortions
- Italy - 4000 additional voluntary legal abortions

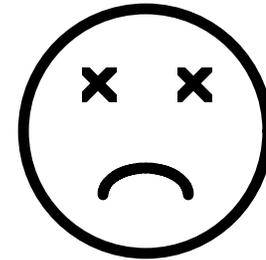
NO ONE WAS EVER TOLD....

Their yearly radiation dose from naturally occurring radon, in Greece and Italy, EXCEEDS the lifetime radiation dose from Chernobyl.

Simplified Linear Model {All Radiation is Harmful}

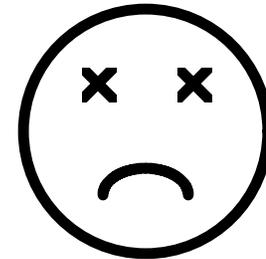


500 rem



LETHAL AMOUNT

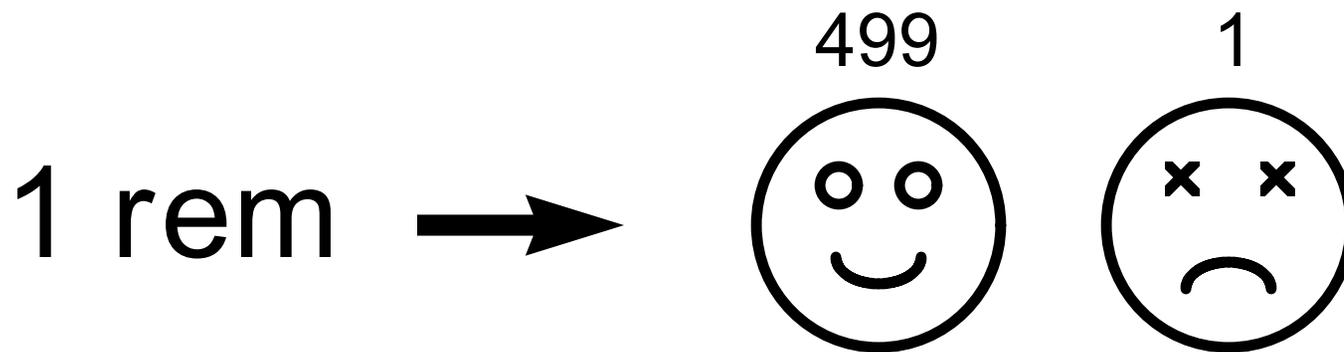
500 ASPIRIN



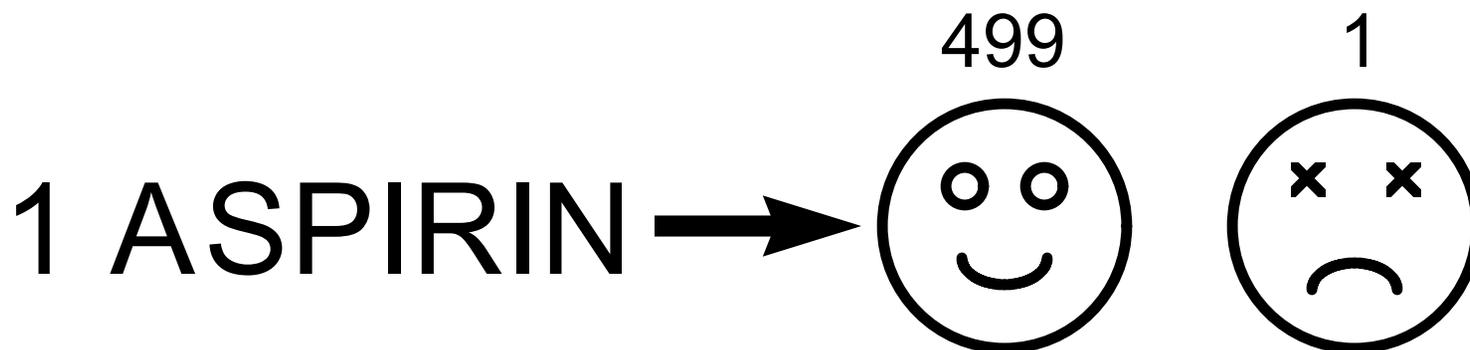
ACID - $C_9H_8O_4$
(discovered 1899)

Acetylsalicylic Acid

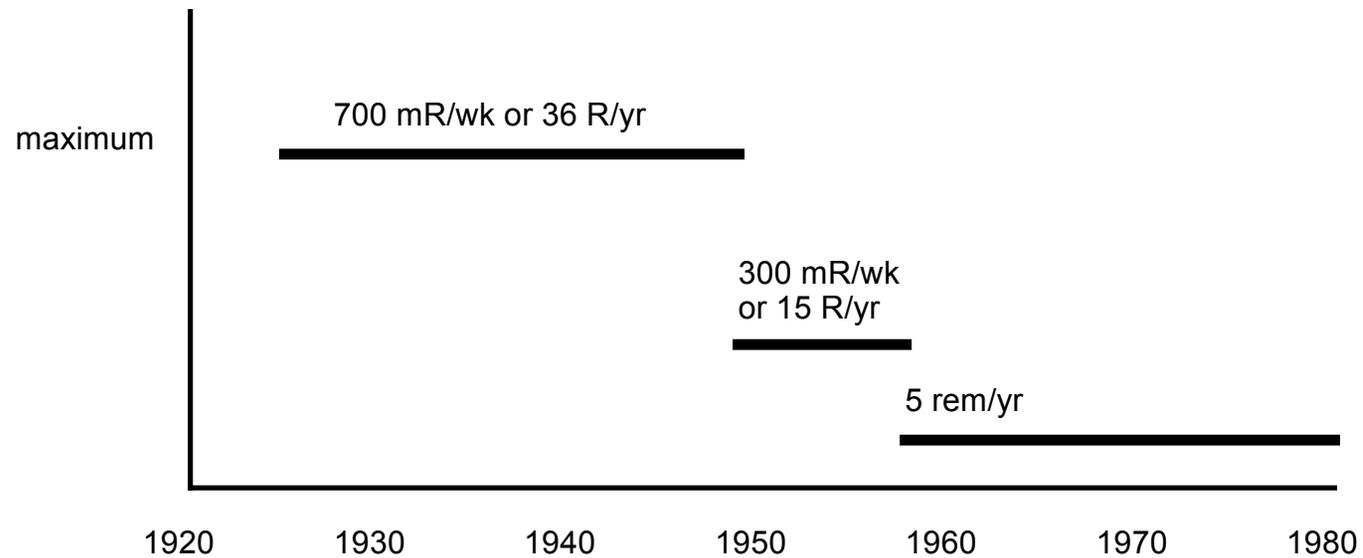
ASPIRIN



1 OUT OF 500
PREDICTED TO DIE



History of Dose Limits



DNA! WHAT ABOUT

DNA?

- 8,000 - 10,000 DNA hits per hour
- naturally occurring - independent of radiation
- primary cause - oxygen

Radiation worker - 5 rem/year

- 20 DNA hits per Rad (rem)
- 100 hits by radiation per year
- 70,000,000 hits non-radiation per year

RADIATION

-

WHAT IS IMPORTANT?